ILC Detector R&D in CD: An Overview

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ILC Coordination Forum
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Agenda

Title	Presenter	Time (min)
Overview	Rob Kutschke	15
SiD Simulations and Benchmarking	Rob Kutschke	15
SiD Forward Tracking	Hans Wenzel	15
Progress and Plans	G.P. Yeh	15
Hardware Acquisition Plans	Lynn Garren	15
IDS Roadmap (maybe)	Mark Fischler	15

Adam Para is on vacation.

ILC Detector Work at FNAL

- R&D for vertex detector and tracking hardware.
  - Marcel Demarteau, Ron Lipton, Bill Cooper
- Muons: detector R&D, testbeam and benchmarks.
  - Gene Fisk, Caroline Milstene (2 publications).
- Physics Benchmarks
  - Aurelio Juste, Rob Kutschke, Caroline Milstene, John Yoh
- SiD Detector Simulations
  - Lynn Garren, Mark Fischler, Rob Kutschke, Hans Wenzel
- Calorimetry: Tech Review, doped Pb-Glass dual RO.
  - Adam Para, Hans Wenzel
- 4th concept
  - G.P. Yeh

This ILC Forum is about work by names in red

External Drivers

- ILC descoped to one IR (10% $ savings).
- Two detectors retained: <u>WWS Statement</u>
  - Redundancy, competition.
  - Push-pull. <u>Goal: Switch over O(1 week)</u> !!!!!!
  - Ideally optimized for different physics scenarios !!!!
- <u>Detector Roadmap</u>
  - Requested by ILCSC, prepared by WWS.
  - Delayed decisions can jeopardize the project.
  - Insufficient resources to keep all options on the table for all detector concepts to completion of TDRs.
    - Aggressively reduce duplicated effort.
    - Down select earlier if that is not enough.
  - Goal: Detector TDRs in 2010 (machine TDR time).

The Detector Roadmap

- 2010: detector design must be at a "similar stage of maturity" to that of the accelerator.
- Timeline:
  - Fall 2008: CDRs from all detector concepts.
    - Concept ≠ Collaboration
  - Down-select to 2 detectors.
    - Form official detector collaborations at this time.
    - Must get this part right!
      - Retain options!
      - Reduce funding for low priority ideas/options!
  - Fall 2010: TDRs due.
  - Ready to build by 2012.
- Background hope: self-merging before down-select.

Research Director and IDAG

- ILCSC would like to appoint a "Research Director" and form an "International Detector Advisory Group" (IDAG).
- Research Director:
  - Will push the roadmap.
  - Ensure appropriate balance of horizontal and vertical R&D.
  - Will provide a single point of contact, representing detctors to the GDE.
- IDAG
  - Advises the RD
  - Probably less than a GDE for detectors.
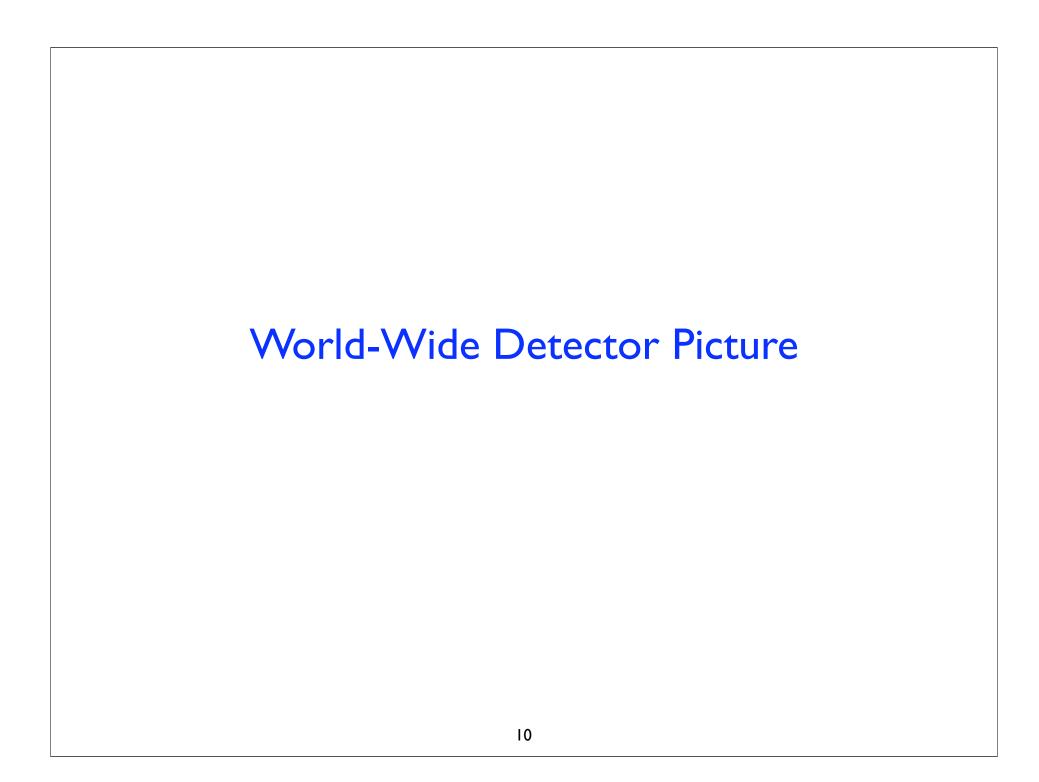
Inconvenient Truths

- By fall 2008, R&D will not produce a clear choice among the competing options.
    - Not even by 2010!
- ILC community will not have resources to do a real TDR, even for one detector, by 2010!
- Imaginary deadlines are a useful management tool but they can also hurt us:
    - NASA is now launching satellites with technology frozen 20 years ago.

My View

- Roadmap and IDAG will happen.
- Important to set a significant milestone for 2010.
  - Need to have an up to date response if there is a discovery at the LHC or TeV.
  - Long enough for significant work to be done.
- It won't really be a true TDR since we won't get the resources to do it.
  - It will be a snapshot of the technical design process.
  - It can be "at the same level as that of the machine".
  - I prefer not to call it a TDR but ...
- Key is to be smart about retaining/rejecting appropriate options at down-select.

Relevant Deadlines

- ALCPG October 22-26, 2007 at FNAL
  - Major status report.
  - Bonus points for showing the flag.
- Spring 2008
  - Software for CDR benchmarks essentially complete.
  - CDR benchmark studies underway.
  - Start writing CDR.
- Fall 2008
  - Submit CDR.

World-Wide Detector Picture

Detector Concepts (July 2007)

- SiD
  - US based. All silicon tracking. PFA calorimetry.
- GDC/LDC
  - Merged just before DESY meeting:
    - GDC: Global Large Detector. Asian based.
    - LDC: Large Detector Concept. European based.
  - Pixel Vertex/TPC tracking/PFA calorimetry.
- 4TH Concept
  - DREAM Calorimeter (Dual REAdout Modules).
  - Dual coil solenoid
  - By far the smallest group.
    - At Argonne told they are too small to survive on their own.
    - Some suggest their calorimeter become an option of SiD.

Comparing Detectors (from DCR)

Detector	Vertex Detector	Tracking System	B Field	Tracker Radius	ECAL	HCAL	Muon/Tail Catcher
SiD	Si Pixels	Si Strips	5 T	1.25 m	W/Si-Pixels	Fe/RPC	Scint/RPC
LDC	Si Pixels	TPC	4 T	1.5 m	W/Si-Pixels	Fe/Scint	RPC
GLD	Si Pixels	TPC	3 T	2 m	W/Scint	Pb/Scint	Scint
4th	Si Pixels	TPC (CLOCOU)	3.5 T	1.5 m	Crystal	DREAM	Dual Solenoid Drift Tubes No Fe!

- TPC based concepts include Si strips to improve forward tracking and to match TPC tracks to vertex detector and ECAL.
- CLOCOU: KLOE-like cluster counting drift chamber.

World Wide Software Status (1)

- 4 Detector concepts
  - 4 Frameworks and 4 build environments.
- Efforts at standardization between SiD and LDC:
  - LCIO: event IO.
  - LCDD: geometry description.
  - Both are incomplete (details in backup slides).
  - Others groups would like to join these efforts but it is a low priority.
- I have personally only run SiD software.
  - My perception is that LDC is more advanced.
  - Some reconstruction code ran in an NLC-era framework and is not yet ported to the new one.

World Wide Software Status (2)

- Goal: highly interchangeable data
  - Run event generator in framework A, detector simulation in framework B, reconstruction in framework C and analysis in framework D.
- I view this as unrealistic.
  - Doable for toy detectors, not realistic ones.
  - A much more limited version makes very good sense
    - Exchange stdhep files and reconstructed objects, neither of which depends on internal details of the detector.
- Someone has actually run their PFA on both SiD and LDC events.
  - How realistic is the detector model? Would it still work with a more realistic model?

The IDS Team at FNAL/CD

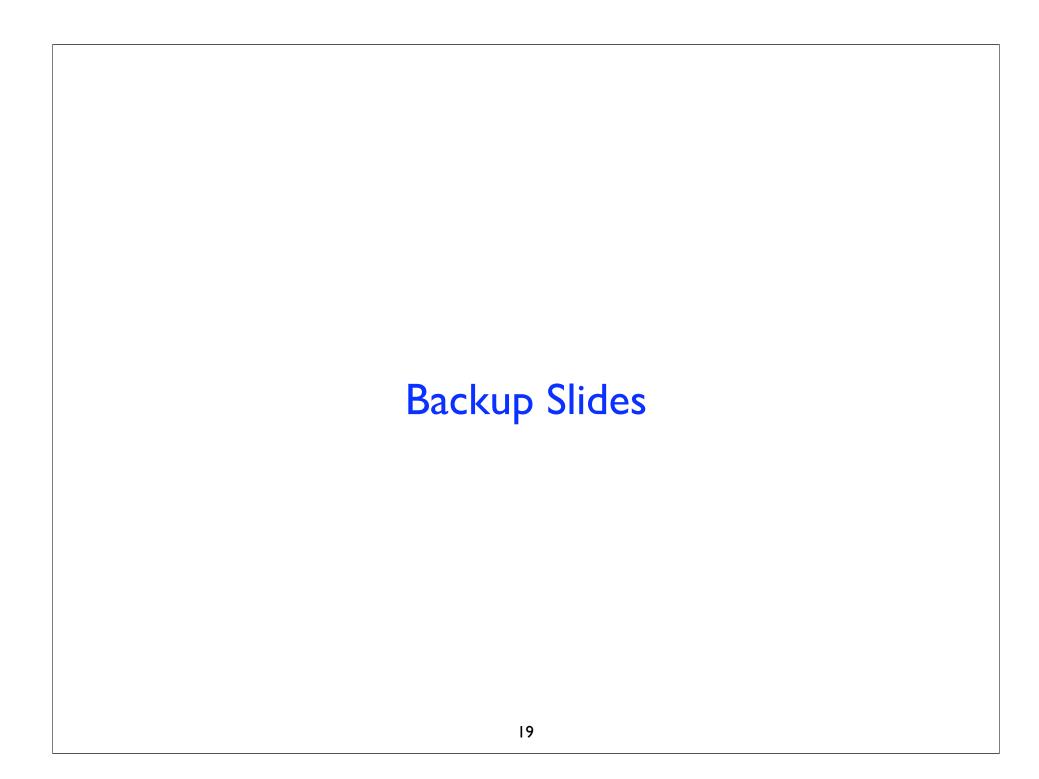|	
Lynn Garren	System admin; software deployment, maintenance and development; web site development.
Mark Fischler	Planning and oversight.
Rob Kutschke	Tracking and vertexing reconstruction software; benchmark analysis.
Adam Para	Calorimeter survey. R&D into doped Pb-Glass calorimetry.
Hans Wenzel	SiD forward tracking software: Sim and reconstruction. Implement doped Pb-Glass in SLIC.
G.P. Yeh	4th concept.
Summer Students:	
Francisco Ruiz	CD; IPN Mexico; working with Hans on tracking.
Daniele Barbareschi	PPD; INFN Lecce (4th); working with Hans on tracking.
Potential Clients:	
Caroline Milstene	PPD. Finishing papers on physics sensitivity in muon channels and on heavy flavor tagging. Plus a summer student.
John Yoh/Aurelio Juste	Starting benchmark work.

What Adam is Up To

- Adam is on vacation.
  - This is my understanding of what he is doing.
- Review of calorimeter technologies that have been discussed for the ILC.
  - Presented at conferences. May be written up?
- R&D into doped Pb-Glass dual readout calorimeter.
  - Hardware:
    - Test beam: measure properties of doped Pb-Glass
    - Bench tests: SiPM. Feedback to Hamamatsu.
  - Software:
    - Hans has coded this as an option within SLIC.
      - Almost complete. See Han's talk.
    - Use this to evaluate the physics reach of this option.

The Next Talks

- Rob
  - SiD detector and software.
  - SiD work taken on by IDS.
  - Details on SiD work not covered in Hans' talks.
- Hans
  - Details on SiD forward tracking
  - Doped Pb-Glass calorimeter in SLIC
- G.P.
  - Progress and Plans on 4th concept.
- Lynn
  - Hardware acquisition plan.
- Mark
  - IDS roadmap document.

Summary

- Detector roadmap and IDAG will be adopted.
- We are down to 3 detector concepts.
  - Some suggest SiD and 4th merge?
- Lots of software, lots of duplication, little coherence.
- Deadlines
  - October/07: ILC workshop at FNAL
  - Spring 08:   Major s/w R&D complete
  - Fall/08:   Submit CDR

Backup Slides

Some Detector Challenges

- Jet energy resolution:
  - Separate W→jet jet from Z→jet jet.
    - $\sigma(m(jet\ jet)) < 3$ or 4 GeV, independent of E(jet jet).
      - $\sigma(E)/E \leq 30\%/\sqrt{E}$ (GeV) for low E; $\leq 3\%$ at high E.
      - Two times better than best achieved at LEP.
- Momentum resolution:
  - Resolve a very narrow, low mass H→μμ.
  - $\sigma(p_T)/p_T^2 \leq 2 \times 10^{-5}$ (p_T in GeV) at high momentum.
- Do much better job in forward region than before.
- Enormous background from beamstrahlung.
  - Both photons and pairs.
  - Pairs at low radii will limit how close vertex detector can come to the beam!
  - Off-axis collisions much worse than on-axis!

Calorimetry Concepts

- Untangle EM/hadronic fluctutions jet by jet.
- Particle Flow Analysis
  - Fine lateral and transverse segmentation.
  - Within each jet, assign each calorimeter hit to: charged track, EM shower, neutral hadron shower.
  - Jet energy = sum of
    - Charged tracks, measured in tracking sytstem
    - + EM energy, measured in ECAL.
    - + Neutral hadron energy, measured in HCAL.
- Dual Readout:
  - Measure both scintillation and Čerenkov light.
  - Untangle EM and hadronic components from light ratio. Info on neutrons from long time tail.
- Neither fully proven.

World Wide Software Status

- 4 Detector concepts
  - 4 frameworks and 4 build environments.
    - Frameworks: Two C++; one Java; one root based.
    - Evolved from legacy systems: NLC, JLC, Aliroot.
  - All use G4. Some can use FLUKA as an option.
- Geometry
  - Everyone has their own tool to digest a geometry description to feed G4 and their own reco code.
  - LCDD:
    - Linear Collider Detector Description.
    - Can be digested by both Europeans and SiD.
      - Others have talked about joining.
    - Only geometry, not material properties.
    - Extension to include material properties promised.
      - Time scale not known.

World Wide Software Status (2)

- LCIO:
  - Joint effort by SLAC and Europeans for event IO.
    - Asians and 4th have talked about coming on board.
  - APIs for Java, C++, Fortran.
  - Weaknesses:
    - No schema evolution.
    - Persistent classes are not very functional for tracking.
    - Crashes if it reads an unrecognized block.
      - Fixed in a recent release that I have not yet tried.
    - No provenance.
    - Collection names free form. No enforced conventions.
  - Bi-directional relations between objects.
  - Coming: new version (root-io back end?).
    - Time scale not known.

World Wide Software Status (3)

- LCFI
  - Linear Collider Flavor Initiative
  - Code to flavor tag jets, using vertexing and leptons-in-jets.
  - C++ only but otherwise concept agnostic.
  - Will use in SiD by writing jets to LCIO files and running LCFI code in its native environment.

Magic Words and Phrases

- **ILCSC:** ILC Steering Committee
  - An adhoc body with influence but no money.
- **WWS:** World Wide Study
- **CDR:** Conceptual Design Report
  - Due Fall 2008.
- **DCR:** Detector Concept Report
  - An attachment to the RDR.
- **TDR:** Technical Design Report
- **RDR:** Reference Design Report
  - The design document for the Accelerator that was released in Beijing. Review is complete about now.
- **PFA:** Particle Flow Analysis

Magic Words and Phrases

- **Dual Readout Calorimetry**
  - Another calorimetry concept.
- **DREAM**
  - Dual REAout Module,
- **IDS:** ILC Detector Simulations (our group in CD).
- **IDAG:** International Detector Advisory Group